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A Computational Approach to Diagnosing Misfits, Inducing Requirements, and Delineating Transformations for Edge Organizations

Abstract

The Edge organization represents a fresh approach to organizational design, moving knowledge and power to the edges of organizations. But this raises issues in terms of comparative performance with respect to alternate organizational designs. Our research stream employs methods and tools of Computational Organization Theory to investigate the design and efficacy of Edge organizations for current and future, military, mission-environmental contexts. This particular study employs a scholarship-based expert system called Organization Consultant to diagnose current military C2 misfits in terms of organizational design. Organizational diagnoses generate relatively fine-grain, prescriptive recommendations for redesigning the organization. We use such prescriptions to induce a set of requirements for Edge organizations and to delineate pathways for organizational transformation: from forms appropriate for Cold War missions of the past, to forms capable of succeeding at Global Terror and other challenging missions of the present and future. This approach is quite novel in the domain of C2 research. Contributions to both theory and practice are made through our presentation, use and illustration of the associated approach. This work suggests immediate results amenable to practical application in the Military. And it suggests also an exciting agenda for continued research along the lines of this investigation.

Introduction

The Edge organization [1] represents a fresh approach to organizational design, which appears to be particularly appropriate in the context of modern military warfare. It proposes to capitalize upon fully connected, geographically distributed organizational participants by moving knowledge and power to the edges of organizations. This highlights promising opportunities for enterprise efficacy. But it also raises issues in terms of comparative performance with respect to alternate organizational designs. Modern military organizations in general have adapted and evolved over many centuries and millennia, respectively. Hierarchy organizations in particular have been refined longitudinally (e.g., through iterative combat, training and doctrinal development) to become exceedingly effective at the missions they were designed to accomplish. In contrast, the many putative benefits and comparative advantages proposed for Edge organizations remain untested hypotheses at best and naïve speculations at worst.

Current conceptualizations of Edge organizations [13, 17] are increasing the level of precision in defining important concepts for evaluating and comparing Edge and other organizational forms. They are beginning to identify key Edge entities and relations. And they are proffering self-report and like scales in attempt to operationalize measurable Edge constructs. But the "theory" underlying such conceptualizations remains as untested and speculative as in the original. Indeed, authors of these current conceptualizations call expressly for testing the claimed superiority of Edge organizations. The problem is, few research approaches exist at present to examine Edge propositions. For instance, it remains unclear even whether informative examples—much less exemplars—of Edge organizations can be identified for study in practice. And attempting to test large-scale military organizations in the laboratory suffers from severe problems with external validity [6]. Likewise, modifying one or more operational military organizations in the field to take on Edge-like characteristics creates problems with internal validity [8].

The research described in this article represents the first stage of a multi-year investigation into the design and efficacy of Edge organizations for current and future, military,

mission-environmental contexts. It builds upon recent work in the command and control (C2) domain [27] to employ methods and tools of Computational Organization Theory (COT) to compare the relative appropriateness of current military organizations (e.g., the Hierarchy) and competing organizational forms (esp. the Edge) for a variety of missions and contexts. COT offers an approach to mitigate the limitations of both laboratory and field research [29]. And by drawing from the extensive research published in the organization studies literature, it can help apply the best, time-proven thinking about organizational design to the new form *Edge*. This approach (i.e., using COT for conceptualization and analysis) is quite novel in the domain of C2 research. Hence one contribution of our research stream centers on exposition of the associated methods, tools and techniques.

This particular study employs a scholarship-based expert system called Organization Consultant [5] to evaluate the mission-environmental fit of current military C2 organizations. The expert system leverages Contingency Theory [12, 14, 39], through automated inference supported by a huge formalization and integration of the literature, to diagnose misfits in terms of organizational design. Based on such diagnosis, the system produces relatively fine-grain, prescriptive recommendations for redesigning the organization. We use such prescriptions to induce a set of design requirements for Edge organizations and to delineate pathways for organizational transformation: from forms appropriate for Cold War missions of the past, to forms capable of succeeding at Global Terror and other challenging missions of the present and future. This approach (i.e., using computational methods to induce organizational design requirements and to delineate transformation pathways) is quite novel also in the domain of C2 research. Our presentation, use and illustration of the associated approach provide another contribution.

The balance of this article begins by drawing from Organization Studies to summarize the Contingency Theory perspective. It provides then an overview of the Organization Consultant and proceeds subsequently to diagnose the relative mission-environmental fit of C2 in the current military. A discussion of results follows, including induction of design requirements for Edge organizations and delineation of pathways for organizational transformation. The article concludes with key implications in terms of military practice as well as research.

Contingency Theory

In this section, we draw from [22] to provide an overview of Contingency Theory. Following [33], *organizational design* is a term reflecting a rational view, in which people and tasks are organized to attain specific goals (p. 33). This view contrasts generally with that of the *natural system*, in which organizations are perceived first and foremost as "collectivities" (p. 56), often with many seemingly irrational aspects. These two views of organizing appear on many levels to represent different poles. For instance, several of the foundational rational organization theorists (e.g., [11, 35, 37, 40]) emphasize the formal organizational structure and work procedures—and the "design" of such structure and procedures to accomplish goals for the organization. This emphasis continues today among many theorists viewing organizations as rational systems.

Alternatively, several of the foundational natural organization theorists (e.g., [3, 18, 31, 34]) emphasize the behavioral processes embedded within organizations and the needs of people being organized. This emphasis continues today among many theorists viewing organizations as natural systems. In further contrast, the rational view is associated often with mechanistic models of organizations, whereas the natural view corresponds more closely with organic models. As with machines, organizations can be designed in the former view, whereas they evolve like living organisms in the latter. Hence on these levels organizational design reflects a rational, often mechanistic view of organizing that emphasizes formal structure and goal attainment, preserving strong contrast with the natural view of organizing.

On other levels, however, the two views of organizations appear to be both mutually compatible and complementary. When considering the organization as an object of design (i.e., as a rational system), for instance, details concerning people (e.g., their diverse backgrounds, talents, interests, needs) are ignored often, and an implicit assumption of people as fungible units surfaces with regularity. Yet organizations are collections of people, and the performance of organizations would be difficult to explain without referring to the people who work in them. Hence

the natural view reminds the rational theorist that people are unique, diverse and important. Likewise, when considering the organization as an ecology of interpersonal behavior, struggle and agency (i.e., as a natural system), for instance, details concerning the legal collectivity (e.g., structure, processes, personnel systems, technologies) are ignored often, and an implicit assumption that the legal entity is irrelevant surfaces with regularity. Yet organizations can accomplish more than the sums of the people in them, and different ways of organizing the same people can affect collective performance. Hence the rational view reminds the natural theorist that organizations have legal, structural and interconnected parts that matter.

With either the rational or natural system view, many scholars agree there is no single best way to organize across all circumstances. This is the central tenet of Contingency Theory [14], which has focused predominately on the environment as a primary determinant of how one should organize. Organizing thus becomes a matter of "fit" with an organization's environment [33, p. 105)]. For instance, Duncan [10] outlines a contingency tree of fit between organizational form and environment for three dimensions: *environmental complexity, environmental change,* and *environmental segmentation*. Depending upon how these three dimensions combine to instantiate a particular environment, several alternate organizational forms may be prescribed (e.g., Functional, Decentralized, Mixed).

Other contingency factors besides the environment are proposed also to guide organizing. For instance, Perrow [32] outlines a contingency table relating organizational form to technology for two dimensions: *task variability* and *problem analyzability.* Table 1 presents the basic aspects of this contingency view. Where the tasks of an organization exhibit low variability (i.e., involving repetition) and problems are analyzable (i.e., amenable to structured problem solving), this table prescribes a "Routine" organizational form (e.g., Functional), for example. Other forms such as "Engineering" and "Craft" imply very different kinds of organizations.

Table 1 Example Contingency Table (adapted from [32])

Problem Analyzability\ Task Variability	Analyzable	Ill-defined
Low	Routine	Craft
High	Engineering	Non-routine

Our consideration of current military and Edge organizations stands to benefit most from just a few of the many different bases for assessing fit, and hence designing organizations, which have been proposed by organization scholars—and tried by organization managers—over the years. For instance, Thompson [39] describes trying to isolate the technical core of an organization from its environment. This results in various layers of an organization, with some focused internally upon efficient work of the technical core and others focused externally, for example, on addressing the vagaries of the organization's environment.

Thompson also proposes organizing on the basis of task interdependencies (e.g., pooled, sequential, reciprocal), among other factors (e.g., environment, domain). Where reciprocal interdependencies (i.e., coordinated through mutual adjustment between people) exist between tasks, such activities would be grouped into the lowest level organizations; that is, people working on reciprocally interdependent tasks (e.g., surgeons and nurses at the operating table) would be organized into the lowest level clusters. These would be followed in turn by tasks exhibiting sequential interdependencies (i.e., coordinated through planning of activities). Continuing with the hospital example, activities such as admission, surgery and nursing represent good candidates to be clustered into higher-level groups according to their sequential interdependencies. Tasks exhibiting pooled interdependencies (i.e., coordinated through standardization) would be clustered at the highest level. Here activities that may not even be hospital-specific, such as payroll, information technology and building maintenance, are nearly independent from one another and represent good candidates to be clustered into separate departments of the hospital organization. Indeed, the pooled interdependency of activities in this class makes them prime targets for outsourcing. One can see the intensity of coupling between different work tasks, and the nature of coordination, drives the level of interdependence and hence organizational clustering in this view.

As another instance, Mintzberg [20] describes the organization in terms of five parts (i.e., operating core, middle line, strategic apex, technostructure, support staff). He proposes five alternate organizational forms (e.g., Simple Structure, Machine Bureaucracy, Adhocracy) that are argued to fit relatively better or worse in terms of different coordination mechanisms (e.g., direct supervision, standardization, mutual adjustment), among other factors (e.g., environment, age and size). A Machine Bureaucracy, for example, would exhibit relatively large "technostructure" (e.g., to develop work standards), "middle line" (e.g., middle managers) and support staff (e.g., accountants). Its principle mechanism for coordination is standardization of work. Many large corporations, government agencies and military commands fit this description well.

Alternatively, a Simple Structure would exhibit negligible technostructure, middle line or support staff, because the specialized kinds of knowledge associated with such parts are not required in a simple organization relying upon direct supervision for coordination. Yet people in the operating core have knowledge of production (i.e., like their counterparts in the Machine Bureaucracy), and those in the strategic apex know about strategy (i.e., like their counterparts in the Machine Bureaucracy) in addition to some management and other specialized areas (i.e., like the middle line, technostructure and support staff of the Bureaucracy). Many small firms, non-profit organizations and military units fit this description well.

Galbraith [12] views organizations as information processing systems, and information work (e.g., associated with coordination and management) is considered on the same level of importance as physical work (e.g., associated with making products or delivering services). Where people are bounded rationally [16] and must receive, process and transmit information to deal with uncertainty (e.g., pertaining to the environment or tasks), information flows and the corresponding costs of coordination become primary determinants of organization. Organizational designs to enhance information flows include various degrees of boundary spanning roles (e.g., interdepartmental liaisons, matrixed project teams), for example, to promote horizontal flows and to ameliorate information processing bottlenecks along vertical channels.

Consolidating an extensive body of the contingency literature and making it explicit via expert system technology, Burton and Obel [5] take the *fit* notion further by outlining six dimensions—management and leadership style, organizational climate, size, environment, technology, strategy—and relating them as a set of contingency factors to organizational form. Speaking practically, a manager could assess his or her organization in terms of such dimensions and use the expert system—essentially a large computerized decision table drawing from Contingency Theory—to identify certain organizational forms that fit relatively better or worse than others. This is the approach taken in the present research.

Organization Consultant

In this section we describe the Organization Consultant and indicate its potential for organizational design in the C2 domain. As noted above, the Organization Consultant is a scholarship-based expert system that employs automated inference. This expert system's knowledgebase is supported by a huge formalization and integration of the Contingency Theory literature. Most such formalization is made in terms of research propositions, expressed via If-Then rules.

For instance, one proposition reads [5, p. 19]: "If environmental complexity is *simple*, and environmental change is *static*, then the organizational structure should be *functional*." Here the symbols "simple" and "static" represent inputs to the system, and the symbol "functional" represents the output. This formalizes one chunk of organization theory as articulated from above [10]. Other, similar chunks from Duncan's theoretical articulation are formalized similarly in terms of rules. Then theoretical chunks from other authors (e.g., [20, 32, 39]) are formalized into additional rules, and so forth, until a substantial segment of the Contingency Theory literature is captured in the knowledgebase.

Clearly all authors from the organization studies literature do not agree with one another. Hence many theoretical chunks are mutually inconsistent. The expert system uses the approach *certainty factors* to integrate such diverse and possibly conflicting theoretical chunks. This approach assigns confidence values to various propositions in the knowledgebase, values that

are combined algorithmically to determine a composite level of confidence in a particular chunk. For instance, if two authors with propositions in the system agree with one another but a third one disagrees, one might expect to see a certainty factor of 0.67 (i.e., two-thirds) associated with the proposition. This represents a long-standing and effective approach to knowledge integration in expert systems.

As noted above, operationally, the Organization Consultant takes as input description of an organization in terms of six dimensions (i.e., management and leadership style, organizational climate, size, environment, technology, strategy). The expert system asks a number of questions to gather inputs in each area. In the area concerning management style, questions pertain to organizational characteristics such as: top management involvement in data gathering and interpretation; top management control over decision-making; top management preferences in terms of proactivity, risk-aversion and control; middle management control over budgets, rewards, hiring and unit evaluation; and others. In the area concerning organization climate, questions pertain to characteristics such as: interpersonal trust, sharing and openness; intra-organizational conflict, disagreement and friction; employee morale, confidence and enthusiasm; resistance to change; leader credibility; and others. Inputs such as these involve judgment and interpretation on the part of the person answering the Organization Consultant's questions.

Size and ownership questions are more objective than those above are. For instance, size is measured principally by the number of employees; the age of the organization is selected from among multiple descriptive categories (e.g., new, mature); and the organization's establishment as a public or private enterprise is input. These represent factual questions. Questions pertaining to technology are similar but require some additional judgment. For instance, the user must determine whether the primary outputs are products or services; whether the technology involves mass production, automation, specialized customization, or some other; how routine (e.g., analyzable, with few exceptions) the technology is; how divisible (e.g., involving decomposable tasks) the work is; the extent of information systems use; and others.

Arguably questions pertaining to the organizational environment and strategy fall somewhere in between those above in terms of judgment required to answer them. In the area concerning environment, questions pertain to characteristics such as: environmental complexity, uncertainty, equivocality, hostility, and others. In the area concerning strategy, questions pertain to characteristics such as: capital requirements; product and process innovation; concern for quality; relative price level; and others.

The Organization Consultant uses inputs gathered through such questions and answers to drive a matching process with its myriad propositional rules and confidence factors. Through the analytical lens of Contingency Theory, it uses evaluation criteria (e.g., *effectiveness, efficiency*, *viability*) to assess the organization's fit in terms of these inputs as well as an overall assessment of appropriateness in terms of its mission and environment. In a natural language format, it associates user inputs with theory through a series of classifications. For instance, it may characterize an organization as "small" or "large" based on the number of employees and the nature of their professionalism. Such classifications are rooted in organization theory. As another instance, it may characterize an organization as having an "internal process climate" or "developmental climate" based on answers to the user's answers provided to questions about organizational climate. As above, such classifications are rooted in organization theory. Theory-rooted classifications in the other areas are provided as well in similar fashion.

Where potential misfits are diagnosed, the Organization Consultant also provides relatively fine-grain, contextualized recommendations for improving fit through different organizational design alternatives. For instance, it may classify the organization as pursuing a "Defender" strategy but recommend that an alternate strategy such as "Analyzer" appears to be more appropriate. As another instance, it may recommend restructuring a "Machine Bureaucracy" along the lines of an alternate organizational form as "Functional Configuration." And it may suggest other structural changes such as decreasing the degree of horizontal differentiation, formalization and centralization. Where multiple recommendations are suggested by the expert system rules and automated inference, it will list each recommendation separately, along with the corresponding certainty factor as an estimate of relative confidence, and explain the characteristics and implications of each. This section on diagnosed misfits and recommendations can be empty or very long, depending upon how well the organizational design appears to be

appropriate for its mission and environment. This approach is quite novel in the domain of C2 research.

As with any computer-based system, the Organization Consultant can be run multiple times for sensitivity analysis. This helps the user to gauge the degree to which one or more particular inputs may be driving the system's classifications, diagnoses and recommendations. To a large extent, this system is relatively robust to small changes in inputs. The inclusion of multiple conclusions and certainty factors augments such robustness. But as with any computer-based system—particularly one that utilizes automated inference—problematic or erroneous inputs will guarantee problematic or erroneous outputs. Prudent modeling procedure calls for users to validate the accuracy and fidelity of their inputs.

Diagnosing Current Military C2 Organizations

In this section we employ the Organization Consultant to diagnose the mission-environmental fit of current military C2 organizations. The unit of analysis for organizational diagnosis is the Joint Task Force (JTF). It represents a multi-Service (e.g., including Air Force, Army, Navy) military endeavor to accomplish some limited and pre-specified set of objectives (e.g., including high-intensity combat, low-intensity operations, peace-keeping). Many, separate and independent JTFs can be formed and operating at any one time. Their constituent compositions, locations and operations may vary widely depending upon the specific missions and environments associated with each. The JTF represents a common and pervasive organizational configuration employed by the US Military and many allied nations today. And it represents the organizational form associated with most, important military missions. The JTF also provides a manageable unit of analysis that balances the enormity of the Department of Defense as a whole with the understandability of small combat units. This represents the most logical unit of analysis for our present purposes.

We begin with analysis of the Hierarchy, the form used to describe the current military C2 organization (see [1]). This analysis takes two steps. We analyze first the current organization in terms of a mission-environmental scenario labeled "Cold War." This is used to characterize the mission and environment that prevailed through the latter half of the 20th Century. We analyze then this same organization in a different scenario labeled "Global Terror." This is used to characterize the problematic mission and environment that is viewed as challenging for the Military today. We compare results of these two steps with current conceptualizations of the Edge organization and use results of the analysis to induce a set of design requirements for Edge organizations. Such requirements enable us to develop research propositions and to delineate pathways for organizational transformation.

Scenario 1 – Cold War

This scenario conceives of the JTF organization back in the relatively stable and predictable Cold War years. Following our discussion of Organization Consultant inputs above, seven key aspects of the JTF are highlighted here: 1) organization size, 2) climate, 3) management style, 4) strategy, 5) organizational characteristics, 6) technology, and 7) perceived misfits. A detailed summary of Organization Consultant inputs and outputs is included in Appendix A.

First, the JTF organization is classified by Organization Consultant as "large." We included the figure of 50,000 employees in our input. This may appear a bit too large for many short-duration and limited-scope missions. But it is probably too small for many extended and broad ones. Particularly when one considers the amount of (even amortized) support from the "home office" DoD ashore and from contractors both at home and abroad, this figure could double or triple easily. Further, the level of professionalism is very high in the JTF. This reflects not only ubiquitous college degrees in the officer corps but also the considerable formal training received by enlisted personnel. This is consistent with the highly specialized jobs of warfare and the limited avenues for lateral entry into the Military. A high level of professionalism such as this makes an organization behave as though it is even larger than it is [5, p. 151-153]. Our estimate of the percentage of JTF employees benefiting from either advanced degrees or specialized training (51

– 75%) implies that the organization behaves like it is roughly four times larger (i.e., 200,000 people).

The JTF organization is classified by Organization Consultant as having "internal process climate." This is consistent with the considerable work formalization, structure, proceduralization, formality and policy guidance employed in the JTF. And this classification is appropriate overall despite some contrary indicators. For instance, the levels of morale and conflict within a JTF organization are all specified as "medium," and both trust (at 50% confidence) and leadership credibility are specified as "high." The 50% confidence factor assigned to high trust indicates that some aspects of trust (e.g., mortal reliance upon others) are high but that others (e.g., internal competition for promotions) are not. These specifications suggest aspects of a "developmental" or a "group" climate. But several attributes of a developmental climate do not appear to match well with the JTF organization: "a dynamic, entrepreneurial and creative place to work; the glue that holds organizations together is commitment to experimentation and innovation; and the organization encourages individual initiative and freedom." The same can be said for the group climate: "a friendly place to work where people share a lot of themselves; success is defined in terms of sensitivity to customers and concern for people; and the organization places a premium on teamwork, participation, and consensus." Nonetheless, such developmental- and group-climate aspects reflect a richer organization than is characteristic of the internal process climate above: "like an extended family; the leaders of the organization are considered to be mentors and perhaps even parent figures; the organization is held together by loyalty or tradition; and commitment is high."

The management style is classified as one of "micro-involvement." This reflects the preference for centralized information flows and decision-making, in addition to pervasive senior management demands for abundant and detailed information. Such micro-involvement is consistent with such preference, with the tendency to use controls instead of incentives, and with the risk-averse nature of JTF management.

The strategy categories derive from Miles and Snow [19] and include colorful terms such as *Prospector, Defender, Analyzer* and *Reactor*. The "Defender" classification appears to fit the JTF organization well. Contributing factors include: "narrow product market domain; top managers … are expert in their organization's limited area of operation but do not tend to search outside their domains for new opportunities; [few] major adjustments in their technology, structure, or methods of operation." This strategy is relatively consistent with risk aversion, commitment to high quality (e.g., safety), and management micro-involvement.

Current organizational characteristics include assessments such as high organizational differentiation, centralization and formalization. Differentiation has three components: horizontal, vertical and spatial. These three components of differentiation reflect, respectively: 1) breadth of organizational tasks and jobs, 2) number of hierarchical levels, and 3) geographical distribution of operations. Centralization pertains to information flows and decision rights being concentrated in the leadership at the organization's center. Formalization pertains to the level of standardization of work processes and written procedures to specify and govern work behavior and performance. These descriptors appear to fit the JTF and most military organizations well.

Technology refers to how the organization transforms inputs into outputs. The military C2 organization is characterized first as a *service*. The Military does not produce products (e.g., automobiles, electronics, music) like many firms do. Although one could stretch the definition a bit to include "delivering bombs onto targets" as a product. But the Military does perform valuable services (e.g., defending the homeland, ejecting invading armies from allied nations, combating terrorism). The C2 organization provides service within the Military in terms of organization, leadership, direction and control. The current JTF organization technology is characterized also as *standard, high-volume*. This reflects the high degree of standardization in terms of weapons, tactics, organizations, training, personnel, procedures and other aspects of military C2. Alternate technology characterizations such as *automation* and *specialized-custom* do not fit nearly as well in this scenario. The JTF technology is characterized further as *semi-routine*. Routineness pertains to the analyzability of work and predictability of associated outcomes. This scenario includes a combination of high and low levels along these lines, hence leading to the classification as "semi-routine." Similarly, the technology is characterized as *semi-divisible*. Divisibility pertains to the decomposability of work tasks into discrete and independent

components. Many aspects of C2 in this scenario are quite decomposable, enabling coordination through standardization (e.g., techniques, tactics and procedures; doctrine), with others less so, requiring coordination through planning (e.g., air tasking orders, campaign plans). But not much of current C2 involves close, reciprocal interaction or requires coordination via mutual adjustment. Hence the semi-divisible classification fits well. Finally, the JTF is characterized as having *strong dominant technology*. This refers to the sophisticated, capital-intensive platforms, networks and systems used for warfare. JTF doctrine in this scenario is based largely on overwhelming force. Hence this classification as "strong" fits well.

Finally, the term *perceived misfits* suggests two aspects of the JTF organization, as summarized above, that do not appear to fit well with the organization's mission and environment. This inference is made by the Organization Consultant. First the Defender strategy is questioned as a possible misfit, because many different factors in a complex environment affect the JTF organization. An Analyzer strategy is suggested as an alternative, through which the JTF would be more proactive in seeking out opportunities. Clearly no single strategy classification fits perfectly, as the JTF does some of this today.

Second, lower horizontal and vertical differentiation is suggested. Given the relatively stable, Cold War environment and internal process focus on a relatively small number of "products" (i.e., distinct mission capabilities), the extreme degrees of specialization and myriad levels of managerial hierarchy appear to be excessive. Low degrees of differentiation are consistent also with a hostile environment and with a management preference for micro-involvement.

Nonetheless, and notwithstanding these two perceived mismatches between the JTF organization and its mission and environment, *this reflects a very good fit*. In other words, the current JTF organization appears to be designed quite well in terms of the Cold War scenario.

Scenario 2 – Global Terror

This scenario projects the JTF organization forward into the highly unstable and unpredictable Global Terror years forecast by many people today. A detailed summary of Organization Consultant inputs and outputs is included in Appendix B. With this Global Terror scenario, most inputs to characterize the JTF organization are the same as those above in the Cold War counterpart. In fact, of the 60 inputs used to characterize the first scenario, 49 are identical in this second one. As in a laboratory experiment, we hold constant the JTF organization. But we vary systematically the nature of its mission and environment. In other words, the same JTF organization as described and analyzed above is assessed in a different mission-environmental context. We change only inputs pertaining to the mission and environment, leaving unchanged those pertaining to the JTF organization.

Table 2 summarizes eleven inputs *that differ* from above and includes the rationale associated with this Global Terror scenario. Briefly, the number of separate locations associated with JTF units is increasing with the number of different terror organizations to identify, locate and address. The increased geographical distance between units follows and reflects a more broadly distributed opposition. More "markets" (i.e., JTF mission requirements and beneficiaries) reflect the expanding role of JTF organizations (e.g., high-intensity conflict, low-intensity conflict, peace-keeping ops, nation-building, information ops, psyops, and anti-terror ops). Also, beneficiaries such as the US and NATO allies as principal "customers" are supplemented by several others now (e.g., in the Balkans, Middle East, Pacific Rim). Plus, the JTF is designed to project power abroad. The increase in number of different products increases proportionately the input associated with foreign "markets."

In terms of technology, the standard, high-volume technology of "putting metal on target" is giving way to many, new, customized solutions to novel problems. This mirrors the expanding number of products and markets noted above. Further, the nature of JTF technology is shifting from semi-routine (e.g., many analyzable problems with few exceptions) to non-routine. And whereas problems and tasks could be decomposed and divided among different, specialized units in the past, missions require now considerable, interdependent interaction between diverse units.

Table 2 Input Differences between Cold War & Global Terror Scenarios

Cold War	Global Terror	Rational for Difference
6 – 15 separate locations	Greater than 30 locations	Many terror organizations to identify, locate and address.
100 – 500 mi ave distance	500 – 3500 mi ave distance	Terror organizations are distributed globally.
Few different markets	Many different markets	Add requirements for low-intensity conflict, peacekeeping ops, nation building, information ops, psyops, and anti-terror ops. Also, the US and NATO Allies as principal "customers" are supplemented by several others.
Few foreign markets	Many foreign markets	The JTF is designed to project power abroad.
Standard, hi-volume technology	Specialized, custom technology	New, customized solutions to novel problems.
Semi-routine technology	Non-routine technology	JTF work has become less routine with less predictable outcomes.
Semi-divisible technology	Indivisible technology	Increasingly reciprocal interrelations between diverse JTF units.
Strong dominant technology	Weak dominant technology	In many aspects of anti-terror ops, the JTF technology remains arguably weak.
Low uncertainty	High uncertainty	SA in a single combat theater is much better (i.e., less uncertainty) than it is in a global terror war.
Low equivocality	High equivocality	Combat in a single theater is well within JTF experience. Combating global terror is not.
High capital	Low capital	Terror requires relatively low capital.

Moreover, prior platform-centric warfare stressed the dominance of machines (e.g., ships, planes, tanks). Network-centric warfare shifts this stress away from the platform. But machines (e.g., computers, networks, decision aids) continue to play a dominant role. The JTF has long pursued and relied upon having a strong advantage in these technological terms. Today, however, in many aspects of anti-terror operations, the JTF technology remains arguably weak. Mortars, rifles and homemade bombs represent weapons of choice by many adversaries today, and C2 is accomplished often via secret meetings, waiving flags and cell phones.

Environmental uncertainty pertains to unknown values of important variables. This is addressed broadly via situational awareness (SA). SA in a single combat theater is much better (i.e., less uncertainty) than it is in a global terror war. Environmental equivocality pertains to novel situations for which the organization has negligible experience. This is addressed broadly via organizational learning. Combat in a single theater is well within JTF experience. Combating global terror is not. Finally, "capital requirement" pertains to the monetary cost of competing in a conflict. Platform-centric and network-centric warfare is expensive, with high capital requirements for technology. Terror involves relatively low capital requirements but can inflict disproportionately high levels of damage. This is a nature of asymmetric conflict.

As a general note, these specific inputs and differences between scenarios are clearly open to a diversity of values and interpretations. However, we have validated these inputs and

differences with experienced military and other knowledgeable informants. They take no issue with this characterization. Also, the results of our analysis are relatively robust to differences in such inputs. The interested reader is welcome to conduct his or her, independent analyses using the appendix values for reference.

In terms of the six key aspects of the JTF highlighted above, organization size remains "large"; climate retains the "internal process" classification (with aspects of "group" also); and management style focuses still on "micro-involvement." Also, organizational characteristics such as differentiation, centralization and formalization remain unchanged between scenarios.

Alternatively, although the Defender strategy remains most prominent, it reveals also strong aspects of both "Analyzer" and "Prospector." The Analyzer seeks to move into new products or new markets only after their viability has been shown. Yet it maintains an emphasis on current products. It has limited innovation related to the production process. This is consistent with the management insistence on micro-involvement.

In contrast with the Analyzer, the Prospector influence entails searching continually for market opportunities and experimenting regularly with potential responses to emerging environmental trends. Quite a bit of such searching and experimenting takes place today. But the Prospector organization is often the creator of change and uncertainty to which its competitors must respond. We see little evidence of this today in the war against global terror.

In terms of perceived misfits, the Organization Consultant identifies many. In contrast to the Cold War scenario above—for which the JTF organization is designed quite well—the Global Terror scenario calls for a substantially different organizational design. Details are summarized in Appendix B. Key highlights include: shifting away from the Defender strategy and more toward the Prospector or Analyzer; breaking up into smaller (possibly specialized) units to address small competitors and low barriers to entry; more decentralization (i.e., less micro-involvement) to keep pace with environmental equivocality and dynamics; promoting a more externally focused climate (e.g., "rational goal" or "developmental") to address environmental dynamism and the JTF's own non-routine technology; lowering its horizontal and vertical differentiation; decreasing its formalization to match its non-routine technology; shifting to media that provide large amounts of information for environmental scanning; shifting to a Simple Structure with flat hierarchy for consistent and rapid responses to unforeseen challenges (a Professional Bureaucracy would also make sense if management would emphasize micro-involvement less); and others. In sum, the current JTF organization *reflects a very poor fit*. In stark contrast with the Cold War scenario above, the current JTF organization does not appear to be designed well in terms of Global Terror.

Comparison with Current Edge Organization Conceptualizations

Two important points pertaining to current conceptualizations of Edge organizations emerge. First, with respect to the Cold War scenario, the current C2 organization (i.e., not Edge) appears to be designed quite well. This is understandable in light of the continuous and extended process of refinement through which military organizations went in response to the Cold War suite of missions and environments. Given that the Edge organization is conceptualized as a dramatic departure from the current organization, and that the current organization fits this Cold War mission-environment scenario well, transformation toward an Edge form makes little sense here. Transformation is time-consuming, disruptive and expensive. It is inappropriate for an organization that fits its mission-environmental context well. This message seems to get lost in some current transformation-oriented organizations.

Second, the opposite holds with respect to the Global Terror scenario: the current C2 organization appears to be designed quite poorly. This is understandable in light of the contrast between Global Terror and Cold War scenarios. Given that the Edge organization is conceptualized as a dramatic departure from the current organization, and that the current organization fits this Cold War mission-environment scenario poorly, transformation toward an Edge form makes great sense here. Further, analyzing the current C2 organization with Organization Consultant produces several, prescriptive recommendations (i.e., as discussed

above) as to how the JTF should re-organize. We use these prescriptions here for comparison with how the Edge organization is conceptualized today.

Beginning with Organization Consultant recommendations that are consistent with current conceptualizations of the Edge organization, three suggestions appear prominently: 1) more decentralization, 2) more externally focused climate, and 3) shifting to media that provide large amounts of information for environmental scanning. Decentralization is clearly central to Edge organization, as units are conceptualized as self-synchronizing, and less managerial micro-involvement is commensurate with self-synchronization. An external focus is central also, as shared awareness and extensive peer-to-peer interactions are stressed in the Edge organization. The shift to information-intensive media (e.g., high-bandwidth communications) is central as well, as a robust, fully connected network and peer-to-peer communications are stressed for the Edge organization. Further, these three recommendations are mutually reinforcing: information-intensive media enable decentralized units to focus externally. This represents a major component of current Edge conceptualization.

Interestingly, the Organization Consultant, which includes *no literature or propositions describing the Edge organization*, identifies these recommendations independently. In this sense, analysis using the Organization Consultant provides evidence to support Edge "theory" through corroboration with the organization studies literature. Likewise, correspondence between Organization Consultant recommendations and Edge "theory" tenets highlights the robustness of this scholarship-based expert system.

However, three recommendations are less clear in terms of Edge consistency: 1) decrease in formalization, 2) shifting to a Simple Structure with flat hierarchy, and 3) breaking up in to smaller units. In terms of the recommended decrease in formalization, notwithstanding novel warfare tenets associated with network-centric operations and agility required for self-synchronization, it remains unclear how informal the Edge organization is conceptualized to be. Would, for instance, formal aspects of warfare such as TTPs, standard operating procedures (SOPs), communication protocols and others become irrelevant in the Edge organization? Moreover, leadership in the Edge organization is conceptualized as being *emergent* and based on situated merit (i.e., at the time and place needed). And communications are conceptualized as being principally *peer-to-peer*. Hence even the Edge organization may find it needs some way to resolve disputes between two or more people who might emerge as leaders at the same time, for instance, or to increase the efficiency and decrease the latency of communications that do not vary from one person to the next (i.e., that benefit from centralized information dissemination). Current Edge conceptualizations imply less formalization. But here we identify an aspect of the Edge organization "theory" that could benefit from elaboration.

Regarding a Simple Structure with flat hierarchy, the Edge organization can be conceived in some respects as simple in comparison to the current C2 organization. For instance, it may have fewer "layers" between the center and edges. But the nature of the Edge organization—with myriad different parts self-organizing and self-synchronizing—does not connote simplicity. Quite the contrary, emergence and entrainment in dynamic systems [4] represent complex behaviors. The complexity of such dynamic behaviors would likely be overwhelming for a Simple Structure on the scale of a JTF organization. Notwithstanding the richly networked, peer-to-peer communication structure envisioned for the Edge organization, and the authority to engage in collaborative, non-hierarchical conversations for shared awareness and coordination, the current conceptualization remains incomplete in articulating how the complex adaptive system of a JTF Edge organization would remain stable. Here too we find an area in which Edge "theory" requires elaboration.

Breaking up into smaller units is a means toward the agility inherent in Edge organization conceptualizations. Small units can be cohesive but can collaborate broadly with other units and self-synchronize to behave like large, custom-designed organizations. This appears to be important to the Edge organization. But such characterization conflicts a bit with current Edge conceptualizations. For instance, the Edge organization is characterized as one that can be large as well as small, using the Global Information Grid and distributed power to morph from one configuration to another [2]. As with the recommended changes above, it remains unclear how this issue of unit size can be resolved without further elaboration of Edge "theory."

Two Organization Consultant recommendations are either unclear or inconsistent with the Edge organization: 1) decreased differentiation, and 2) change to a Prospector strategy. Differentiation here pertains only to horizontal and vertical components. The Military represents a very diverse set of skills and capabilities. The breadth of capabilities needed to combat global terror appears to be *larger* than the current set, not smaller. Hence horizontal differentiation appears to remain a part of the Edge organization. This, however, is not clear in the Edge conceptualization, suggesting that the Edge "theory" needs to be elaborated along this dimension as well. In contrast, decreasing vertical differentiation is entirely consistent with the Edge organization conceptualization. Indeed, an organization with power pushed to the edge has little need for large hierarchy and its associated vertical differentiation.

Finally, the Prospector strategy is one in which the organization seeks actively new opportunities. It searches continually for market opportunities and experiments regularly with potential responses to emerging environmental trends. Such organization is often the creator of change and uncertainty to which its competitors must respond. Strategy is difficult to analyze outside of a game-theoretic perspective. But to the extent that the JTF—whether as Hierarchy or Edge—can dictate terms of engagement to its foes, then the Prospector strategy may be feasible. Alternatively, to the extent that asymmetric warfare keeps the JTF guessing, in a reactive mode, and to the extent that adversaries with low capital barriers to entry are able to inflict asymmetrically great damage upon the US and allied militaries, then the JTF—whether as Hierarchy or Edge—must retain at least some aspects of the Defender and Analyzer strategies. This represents a question about which the current Edge "theory" remains silent.

Edge Organization Design Requirements

In this section, using recommendations from the Organization Consultant for guidance, we can induce a set of design requirements for an Edge organization to perform effectively in the kind of mission-environmental context associated with our Global Terror scenario. In essence, the Organization Consultant outlines the forms, functions and properties that an organization should have to fit this mission-environmental context well. This discussion serves to extend current conceptualizations of the Edge organization through application of our scholarship-based expert system and the substantial knowledge of organization theory that it brings to bear on the question. We use Table 3 to summarize such Edge organization design requirements. It is organized according to the six input areas considered by the Organization Consultant. The corresponding discussion treats each design requirement as a research proposition. Such propositions can be operationalized to form the basis of testable hypotheses and can help guide future research to conceptualize, develop and refine the Edge organization. The informed Reader will notice that most of these propositions represent contrasts with the manners in which JTF organizations operate today. This suggests that transformations will be necessary for each.

Proposition 1. The Edge organization should be composed from relatively small and discrete units.

This represents a contrast with the large JTF organizations that operate today. With many small, possibly specialized units, the JTF can be much more flexible in how, when and where it combines various C2 and fighting capabilities to respond to a dynamic and unpredictable environment. However, a great many such relatively small units can still organize together to create mass effects and to conduct effects-based operations that require scale and diversity of forces. By modularizing many small units, the Edge organization can achieve its conceptualized ability to morph into different configurations.

Proposition 2. The Edge organization climate should be focused externally, with fewer written rules and procedures, to enhance agility.

This represents a contrast also with the internally focused JTF organizations that operate today. Although the Rational Goal climate emphasizes the accomplishment of objectives and has some

resemblance with contemporary JTF organizations, the Developmental environment is characterized in part above as: a dynamic, entrepreneurial and creative place to work; the glue that holds organizations together is commitment to experimentation and innovation; and the organization encourages individual initiative and freedom. This characterization has much less resemblance with C2 in the JTF organization today.

Proposition 3. The Edge organization should have a management style with little micro-involvement.

This represents a major contrast with the centrally controlled JTF organizations that operate today. Delegation will be important clearly. But so will knowledge flows. People toward the edges of organizations need more than the authority to make formerly centralized decisions and more than opportunity to coordinate and communicate laterally instead of vertically. They also need more than to *know what* to do and when. They need to *know how* to make formerly centralized decisions (e.g., involving strategy, requiring high-level perspective, based upon decades of military experience); to *know how* to coordinate and communicate laterally instead of vertically (e.g., to learn who knows what, to post and search just in time for knowledge and information, to manage reciprocally interdependent activities); and *know how to* do what is required and to determine when it is required. Without micro-involvement by the leadership at the center of the organization, the requisite knowledge must flow rapidly and reliably to the edges. Coordination and collaboration through meetings can enable some of the necessary kinds of rich, situated, experience-based tacit knowledge to flow. Technologies to support heavy and rich information flows through communications (discussed below) are necessary in the kind of geographically distributed mission-environmental context of the JTF. But they are unlikely to be sufficient. Basing incentives on results as opposed to activities follows here as well, as does allowing employees more latitude to deviate from rules and procedures, written or not (i.e., deviating from norms and customs as well as from standards and procedures).

Table 3 Edge Organization Design Requirements

Organization Area	Design Requirements
Organization size	Small, possibly specialized units
Climate	Externally focused: Rational Goal or Developmental; use fewer written rules and procedures
Management style	Less micro-involvement; rapid & reliable knowledge flows; incentives based on results; coordination through meetings; allow employees more latitude
Organizational characteristics	Less centralization, differentiation and formalization; Simple Structure with flat hierarchy
Technology	Specialized, custom, non-routine, indivisible, low-capital, heavy & rich information flows
Strategy	Prospector or Analyzer

Proposition 4. The Edge organization should exhibit low degrees of centralization, differentiation and formalization, along with a Simple structure exhibiting flat hierarchy.

Decentralization involves pushing agency and decision rights toward the edges of the organization and enabling people and units at the edges to learn independently and to coordinate

laterally. Less horizontal differentiation implies fewer different jobs and areas of specialization in the JTF organization. More people will be generalists than specialists. But with the dynamic, unpredictable environment and diversity of mission requirements anticipated in the future, people and organizations will need to develop a capability for rapid learning—often just in time—to perform effectively as generalists. Less vertical differentiation implies fewer hierarchical levels in the JTF organization. Not only should people and units at the edges of the organization be empowered, but also people and units in between the center and the edges of the organization should be reassigned and eliminated, respectively. Less formalization implies fewer written rules and procedures, along with less formality and standardization. A greater tolerance for diversity, experimentation, and even failure (with learning associated), along with lesser reliance on formal doctrine, TTPs, SOPs and the "one right way" to do things, is required. The Simple Structure involves a shift from coordination through standardization of work processes to coordination by direct (unit-level) supervision, along with professional competency and rapid learning.

Proposition 5. The Edge organization should develop technology that is specialized, custom, non-routine and indivisible, requiring low capital investments and enabling heavy and rich information flows.

A qualitatively different technology is required for the JTF organization. To address mission diversity, the technology should be specialized and custom, not standardized and high-volume. To address environmental dynamism and unpredictability, the technology should be non-routine. To enable self-synchronization of smaller, distributed, empowered units, the technology should be indivisible, requiring coordination through mutual adjustment. To address the asymmetric nature of warfare, the technology should not be capital intensive, costly and slow to develop. Rather, the technology should reflect the same level of capital required of adversaries. Large, multi-billion-dollar, inadaptable weapon platforms and information systems of today—requiring decades to specify, design and build—are out in this view. Small, inexpensive, tailored weapons and intelligence systems are in. Further, we note above the need for technologies to support heavy and rich information flows through communications—and the associated tacit knowledge flows—in the kinds of geographically distributed mission-environmental context of the JTF. Combining these latter two requirements (i.e., small, inexpensive, tailored weapons and intelligence systems vs. heavy and rich, geographically distributed information systems) is certain to be a challenge.

Proposition 6. The Edge organization should pursue a Prospector or Analyzer strategy.

This represents a contrast with the Defender strategy pursued by JTF organizations that operate today. As noted above, the Prospector strategy entails searching continually for new opportunities and experimenting regularly with potential responses to emerging environmental trends. Quite a bit of such searching and experimenting takes place today. But the Prospector organization is often the creator of change and uncertainty to which its competitors must respond. In the war against global terror, this requires more knowledge about how to identify and neutralize adversaries in advance of their actions. The Analyzer seeks to move into new products or new markets only after their viability has been shown. Yet it maintains an emphasis on current products. Here, the terms *products* refer to mission capabilities and *markets* refer to mission requirements. This strategy is closer to the current Defender practiced by JTF organizations today. Hence it may represent a step toward transformation to a Prospector strategy.

Edge Transformation Pathways

In this section, we expound upon the organizational design requirements summarized in the table above to delineate transformation pathways associated with each of the six organization areas. As such, we extend further current conceptualizations of the Edge organization. In addition to outlining *what* the Edge organization should look like in terms of its form, configuration and other design requirements, through this analysis we also articulate *how* the Military can transform its current C2 organizations and processes to become more Edge-like. As noted above, most of the

design requirements—and the corresponding research propositions—provide a contrast with the manners in which current JTF organizations operate. The pathways discussed in this section suggest avenues for transformation required for military C2 to change accordingly.

Table 4 Edge Transformation Pathways

Design Requirements	Transformation Pathways
Small, possibly specialized units	Start with the modular and generalist nature of the SEAL and Special Forces teams. Develop coordination mechanisms, processes, education programs and technologies to experiment with. Learn how such units can combine with large (or even small) numbers of other units to self-synchronize actions and to form large coherent forces. Promote experimentation in a specifically designated JTF. Consider a 50,000-person SEAL team!
Externally focused: Rational Goal or Developmental; use fewer written rules and procedures	Start with the modular and generalist nature of the SEAL and Special Forces teams. Promote experimentation in a specifically designated JTF. Grant leaders and members great flexibility. Bring in organization scholars. Use university research and open-source software development organizations as exemplars.
Less micro-involvement; rapid & reliable knowledge flows; incentives based on results; coordination through meetings; allow employees more latitude	Use same transformation pathway as outlined above for changing the organization climate. Conduct research to study which knowledge-flow approaches are most effective for the various kinds of knowledge gaps and task domains.
Less centralization, differentiation and formalization; Simple Structure with flat hierarchy	Use same transformation pathway as outlined above for changing the organization climate. Conduct research to study *how much* centralization and other factors is appropriate. Study other organizational archetypes for coordination insights. Employ methods of computational experimentation.
Specialized, custom, non-routine, indivisible, low-capital, heavy & rich information flows	Use same transformation pathway as outlined above for changing the organization climate. Conduct research to study alternate combinations of technologies and other organizational characteristics, across varying mission-environmental contexts. Employ methods of computational experimentation.
Prospector or Analyzer	Move from Defender to Analyzer as a step toward adopting a Prospector strategy. Move deliberately into new mission areas. Develop new mission capabilities as needed. Search continually for new opportunities. Experiment regularly with potential responses to emerging environmental trends. Develop and study a robust, high-fidelity model of adversaries' organizations.

In something of a departure from the preceding analysis, here we venture beyond the theory-based safety of the Organization Consultant and propose our own, informed recommendations. The Organization Consultant is proficient at diagnosing misfits and pathologies and at recommending *what* to do to address them. But it offers little support in terms

of suggesting *how* to transform the organization accordingly. Our research on and experience with change management (e.g., [25, 26, 28]), along with knowledge dynamics (e.g., [23, 24, 29]), guides this prescription. Although this is admittedly a more speculative aspect of the present article, it provides actionable, transformational guidance for leaders, managers and policy makers today. And it provides guidance for empirically focused, computational, laboratory and field research to assess the relative efficacy of alternate Edge organization designs. These transformation pathways are summarized in Table 4.

Beginning with the organization requirements to form small, possibly specialized units, we look first at units in the Military and elsewhere that exhibit Edge-like properties today. Navy SEAL teams and Special Forces teams from other Services demonstrate many Edge characteristics. Their missions are diverse. Their environments are dynamic and unpredictable. They train more as generalists than their counterparts in other units do. Deployed teams are granted huge discretion within predefined limits. Coordination within a planned operation is largely through mutual adjustment. And other Edge-like characteristics pertain as well. But such units operate independently for the most part. That is, they cannot combine with large (or even small) numbers of other units to self-synchronize actions or to form large coherent forces. Hence they do not conform to current Edge conceptualizations. But still, the modular and generalist nature of the SEAL and Special Forces teams may provide a starting point for re-organizing the JTF along the lines required in the tables above. As an approach to transformation, we recommend that one, specifically designated JTF be re-organized as such at first and used for experimentation. Computational experiments, as well as those conducted in laboratories and in the field, can be helpful in this regard to foster rapid learning. Consider, as an objective test of *Edgeness*, a self-organizing and self-synchronizing SEAL team that is 50,000 people strong!

The requirement to develop an externally focused organization climate, with fewer written rules and procedures, involves deep transformation that is likely to embody heavy and high-level resistance to change in the Military. But as with our transformation path outlined above for the smaller units, one could start with the modular and generalist nature of the SEAL and Special Forces teams and promote experimentation in a specifically designated JTF. Let the leaders and members of such teams and JTF have great flexibility in trying to develop a different culture and organizational climate. Incentivize them heavily to deviate from current military TTPs, SOPs, norms and culture. Bring in organization scholars as change agents to help devise structures, incentives, coordination mechanisms and technologies that will promote this kind of climate. Incorporate selective characteristics of other kinds of organizations that exhibit Edge-like characteristics as exemplars.

One candidate exemplar in this regard involves university research. The university represents an epitome of the *knowledge organization*. Aside from a few buildings, desks and computers, the university is comprised of little more than the knowledge of people and written works that participate in research and education. University researchers (cf. educators) in particular behave according to quasi-market forces. Despite being embedded in a loose-hierarchical administrative structure [15], such researchers are free: to select their own problems to work on; to take whatever approach to problem solving they feel is appropriate; and to devote as much or as little time and energy to any particular problem as they see fit. They are evaluated by their peers and collaborate across organizational boundaries as often, if not more, than within them. Indeed, in terms of current Edge conceptualizations, university researchers self-organize and self-synchronize into collaborative partnerships, teams and consortia, which can change, disband and reconstitute themselves dynamically. Such dynamic behavior is quite Edge-like. University researchers are at the edges of the organizations, where they meet and interact with the environment to conduct research, and they operate with negligible direction or involvement from the organizational center.

Another candidate exemplar involves open-source software development. Various people—who are not part of a common organization—work (often for free) on whatever parts of software development that they choose to. A small core of people at the organizational center assembles and integrates the various parts. But the developers at the edges of the organization—indeed, beyond the organization itself in a formal sense—interact directly with the environment to develop software, and they operate with negligible direction or involvement from the organizational center. Weaving into SEAL and Special Forces teams the kinds of

characteristics described here (i.e., for university research and open-source software development) offers potential to enrich the organizational behaviors and to increase the requisite variety of military C2.

The requirement for less managerial micro-involvement involves deep transformation that is likely to embody heavy and high-level resistance to change in the Military also. The transformation pathway outlined above in terms of changing the organization climate applies well here too. But the need to enable rapid and reliable knowledge flows requires a complementary pathway. This is the case in particular where tacit knowledge is involved. Such tacit knowledge is developed today generally through the accumulation of on-the-job experience, which can take years or even decades. Several alternate approaches to enabling tacit knowledge flows are available (e.g., trial and error, classroom training, formal education, mentoring, immersive simulation). And each has its relative advantages and disadvantages. Individuals, teams and larger organizational collectivities will have different knowledge gaps across various task domains. It will be important to study which approaches are most effective for the various kinds of gaps and domains. Research along these lines is ongoing now. Techniques from above such as computational, laboratory and field experimentation are all appropriate here.

The requirement for less centralization, differentiation and formalization, combined with a Simple Structure and flat hierarchy, follows also a pathway similar to that articulated above in terms of changing the organization climate. This will require research to study *how much* centralization, differentiation and formalization fits best with different organizational characteristics and with varying mission-environmental contexts. Research to study combinations of coordination mechanisms associated with Simple and other organizational archetypes (e.g., Professional Bureaucracy, Adhocracy) is necessary as well. Given the exponential number of different and potentially relevant and significant combinations of factors to study, computational experimentation appears to represent the most promising approach to such research at present.

As noted above, the requirement to change the JTF technology to become specialized, custom, non-routine, and indivisible, and to require low capital yet enable heavy and rich information flows, will be challenging. A similar transformation pathway (i.e., like the one described above in terms of organization climate) is recommended to address this requirement as well. Research to study alternate combinations of technologies and other organizational characteristics, across varying mission-environmental contexts, is necessary here also. And the exponential number of different and potentially relevant and significant combinations of factors to study makes computational experimentation equally appropriate for such research.

Finally, the requirement to develop a Prospector strategy involves more knowledge about how to identify and neutralize adversaries in advance of their actions. As noted above, moving from Defender to Analyzer represents a step toward adopting a Prospector strategy. This two-step tactic can help to mitigate risk and resistance to change. The first step is to move deliberately into new mission areas and to develop new mission capabilities as needed. In many cases, such capabilities can be developed through unique compositions of small, modular units that exist today (e.g., SEAL and Special Forces teams, university research collaborators, open-source software developers). But in others, wholly new capabilities (e.g., anti-terror), within units, will need to be developed. The next step is to search continually for new opportunities and to experiment regularly with potential responses to emerging environmental trends. The JTF should learn to become the creator of change and uncertainty to which its competitors must respond. Developing and studying a robust, high-fidelity model of adversaries' organizations can help to accelerate individual and organizational learning in this regard.

Conclusion

The Edge organization represents a fresh approach to organizational design, moving knowledge and power to the edges of organizations. But this raises issues in terms of comparative performance with respect to alternate organizational designs. Our research stream employs methods and tools of Computational Organization Theory to investigate the design and efficacy of Edge organizations for current and future military mission-environmental contexts. This particular study employs a scholarship-based expert system called Organization Consultant to diagnose current military C2 misfits in terms of organizational design. Organizational diagnoses generate

relatively fine-grain, prescriptive recommendations for redesigning the organization. We use such prescriptions to induce a set of requirements for Edge organizations and to delineate pathways for organizational transformation: from forms appropriate for Cold War missions of the past, to forms capable of succeeding at Global Terror and other challenging missions of the present and future. This approach is quite novel in the domain of C2 research. Contributions to both theory and practice are made through our presentation, use and illustration of the associated approach. This work suggests immediate results amenable to practical application in the Military. And it suggests also an exciting agenda for continued research along the lines of this investigation.

In particular, to the extent that the JTF—our selected unit of analysis—faces mission-environmental contexts that are similar to the Cold War scenario examined in this study, there is little apparent need to transition from the current organization to the Edge or any other form. *Transformation* for the sake of transformation makes little apparent sense (e.g., consider the grammatically poor aphorism, "if it ain't broke, don't fix it!"). The current organization and Cold War scenario fit one another very well. But to the extent that the JTF faces mission-environmental contexts that are similar to the Global Terror scenario examined in this study, there is great apparent need to transition from the Hierarchy organization to the Edge or some other form. The current organization and Global Terror scenario fit one another very poorly.

Results of our analysis using the Organization Consultant serve to extend current conceptualizations of the Edge organization across several fronts. For one, we identify numerous, specific aspects of the current military C2 organization that need to change in order to improve the fit with the mission-environmental context of global terror. This provides a theory-based set of organizational design prescriptions that we compare with current conceptualizations of the Edge organization. For another, we induce a set of organizational design requirements for the Edge organization, which we characterize in terms of research propositions. This augments extant Edge "theory" through the time-honored and well-accepted lens of Contingency Theory. And it provides a well-grounded link between Edge conceptualization and Organization Theory. For a third, we identify a set of transformation pathways corresponding to the design requirements from above. This provides actionable, transformational guidance for leaders, managers and policy makers today. And it provides guidance for empirically focused, computational, laboratory and field research to assess the relative efficacy of alternate Edge organization designs.

Additionally, both concurrent and future research—through respective parallel and subsequent stages of the current project—along the lines of this investigation is planned as well. In terms of concurrent work, research that involves methods of computational experimentation—using a system called Projects, Organizations and Work for Edge Research (POWer)—through dynamic performance emulation is being conducted in parallel with the present work that uses the Organization Consultant expert system. Such parallel research takes a dynamic model of some organization, in a particular mission-environmental context, and emulates the behavior and performance of such organization as a function of simulated time. This approach is being used to test hypotheses pertaining to the putative benefits of Edge organizations and to extend our current conceptualization of the Edge organization. POWer models of Edge and other organizational forms are developed through study of archetypes from the organization studies literature. And they are informed by diagnoses and prescriptions of the Organization Consultant in the present study. Such research not only builds upon but clearly complements that described in the present article. Computational experimentation provides empirical results that help also to identify regions of mission-environmental space that fit Edge organizations relatively better or worse than current organization and other forms do. And the emergent behaviors emulated through such research are helpful further for identifying limits to the efficacy of the Edge: the edge of the Edge.

This pertains in an extreme way to the notion of complexity and how the kind of JTF-scale organization characterized as *Edge* could remain stable. Some research to date (e.g., see [7]) suggests that an organizational form such as Edge—in particular, one that is large, decentralized and richly connected—is likely to be chaotic. Additional research is needed to evaluate the dynamics of the Edge and other alternate organizational forms under various conditions to examine the linkages between performance and stability. The kind of agent-based, dynamic emulation associated with computational experimentation [27] offers good potential here, as do other approaches that seek to balance factors such as *agility* and *control*.

In terms of future work, this present investigation can be extended by using the Organization Consultant to analyze Edge organizations directly. In this present article, we describe the use of Organization Consultant to analyze the *current military organization* (i.e., not Edge) in two different mission-environmental contexts. Alternatively, in the future work, we plan to use this scholarship-based expert system to analyze *the Edge organization directly*, examining the two scenarios described here (i.e., Cold War and Global Terror) as well as others. This will require improved conceptualization of the Edge organization. For instance, many specific organizational characteristics remain under-defined or unaddressed at present. These include: the number and breadth of different jobs; the extent to which job descriptions and organizational processes are described in writing; unit size and span of control; management tendencies such as involvement in decision making details, proactivity and risk; organization climate factors such as motivation, incentives and scapegoating; and other factors such as the level of innovation that can be achieved and sustained, the relative cost of operations with respect to adversaries, and the level of resistance to change that persists in the organization. As conceptualizations of the Edge organization become progressively better articulated (e.g., through this research and that of others), our modeling and analysis using computational methods will progress in step. And through our computational methods, we continue to push forward conceptualization of the Edge organization.

Additionally, our project team is working on multiple theoretical and developmental fronts that will serve to inform and to extend the depth and range of research associated with the present work. One such front involves the development and application of knowledge dynamics to characterize Edge organizations. This work draws from emerging knowledge-flow theory [23, 24, 29] to characterize phenomenologically the manner in which knowledge flows across different people, organizations, places and times. Because knowledge is required for action, and action is required for power, distributing power to the edges of organizations requires concomitant distribution of knowledge to enable the underlying actions. Current Edge conceptualizations are relatively silent on this matter. This is the case in particular as knowledge is distinct from information [9, 30, 38]. Incorporating behaviors of knowledge dynamics into computational tools such as Organization Consultant and computational experimentation platforms such as POWer will increase the fidelity and dynamics of organizational models that can be developed and examined. Similar work to develop, apply and incorporate behaviors associated with trust and culture offers potential for comparable effects. Such effects will improve in turn our conceptualization of Edge organizations. This can expand the range of organizational forms, missions and environments that can be examined computationally. And it can create subsequently other, new research questions and computational capabilities to be addressed through continued theoretical and developmental work, respectively.

Further, in addition to theoretical and developmental research associated with computational work, the stream of research associated with this project also contemplates empirical studies, both in the laboratory and particularly in the field. Although the computational models being used and developed in the present, concurrent and future research from above have the benefit of extensive internal and external validation, our application of such models to the C2 domain in general, and to Edge organizations—which for the most part do not yet exist— in particular, represents novel research. This requires fieldwork to validate the model specifications and behaviors, as well as to apply and evaluate the kinds of insights and recommendations generated through this research. Fieldwork can drive additional theoretical insight through induction as well, which can drive in turn further model development, and the subsequent expansion of organizational forms, missions and environments that can be analyzed and emulated. Laboratory research is similar. Indeed, these multiple types of research— theoretical, developmental, computational, field and laboratory—complement one another richly. When integrated into a coherent research stream, they enable the kind of progressive and cumulative accretion of new knowledge that represents a hallmark of science. This represents a relatively novel approach to generating new knowledge in the C2 domain, particularly as it pertains to the Edge organization.

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Appendix A – Cold War Scenario

REPORT SUMMARY - JTF

Time: 11:08:28 AM, 3/4/2005
Scenario: Cold War

INPUT DATA SUMMARY

The description below summarizes and interprets your answers to the questions about your organization and its situation. It states your answers concerning the organization's current configuration, complexity, formalization, and centralization. Your responses to the various questions on the contingencies of age, size, technology, environment, management style, cultural climate and strategy factors are also given. The writeup below summarizes the input data for the analysis.

- JTF has a machine bureaucracy configuration (cf 100).
- JTF has a large number of different jobs (cf 100).
- Of the employees at JTF 51 to 75 % have an advanced degree or many years of special training (cf 100).
- JTF has more than 12 vertical levels separating top management from the bottom level of the organization (cf 100).
- The mean number of vertical levels is 9 to 12 (cf 100).

- JTF has 6 to 15 separate geographic locations (cf 100).
- JTF's average distance of these separate units from the organization's headquarters is 101 to 500 miles (cf 100).
- 61 to 90 % of JTF's total workforce is located at these separate units (cf 100).
- Job descriptions are available for all employees, including senior management (cf 100).
- Where written job descriptions exist, the employees are supervised closely to ensure compliance with standards set in the job description (cf 100).
- The employees are allowed to deviate very little from the standards (cf 100).
- 81 to 100 % non-managerial employees are given written operating instructions or procedures for their job (cf 100).
- The written instructions or procedures given are followed to a very great extent (cf 100).
- Supervisors and middle managers are to a little extent free from rules, procedures, and policies when they make decisions (cf 100).
- More than 80 % of all the rules and procedures that exist within the organization are in writing (cf 100).
- Top Management is to a very great extent involved in gathering the information they will use in making decisions (cf 100).
- Top management participates in the interpretation of more than 80 % of the information input (cf 100).
- Top management directly controls more than 80 % of the decisions executed (cf 100).
- The typical middle manager has some discretion over establishing his or her budget (cf 100).
- The typical middle manager has no discretion over how his/her unit will be evaluated (cf 100).
- The typical middle manager has no discretion over the hiring and firing of personnel (cf 100).
- The typical middle manager has no discretion over personnel rewards - (ie, salary increases and promotions) (cf 100).
- The typical middle manager has some discretion over purchasing equipment and supplies (cf 100).
- The typical middle manager has no discretion over establishing a new project or program (cf 100).
- The typical middle manager has little discretion over how work exceptions are to be handled (cf 100).
- JTF has 50000 employees (cf 100).
- JTF's age is mature (cf 100).
- JTF's ownership status is public (cf 100).
- JTF has few different products (cf 100).
- JTF has few different markets (cf 100).
- JTF operates at a high-activity level in more countries (cf 100).
- JTF has few different products in the foreign markets (cf 100).
- JTF's major activity is categorized as service (cf 100).
- JTF has a standard high-volume service technology (cf 100).
- JTF has a medium routine technology (cf 100).
- JTF's technology is somewhat divisible (cf 100).
- JTF's technology dominance is strong (cf 100).
- JTF has either planned or already has an advanced information system (cf 100).
- JTF's environment is complex (cf 100).
- The uncertainty of JTF's environment is low (cf 100).
- The equivocality of the organization's environment is low (cf 100).
- JTF's environment is extremely hostile (cf 100).
- Top management prefers to make general decisions as well as detailed operating decisions (cf 100).
- Top management primarily prefers to make both long-term and short-time decisions (cf 100).
- Top management has a preference for very detailed information when making decisions (cf 100).
- Top management has a preference for proactive actions (cf 100).
- Top management is risk averse (cf 100).
- Top management has a preference for high control (cf 100).

- JTF operates in an industry with a high capital requirement (cf 100).
- JTF has a medium product innovation (cf 100).
- JTF has a medium process innovation (cf 100).
- JTF has a high concern for quality (cf 100).
- JTF's price level is high relative to its competitors (cf 100).
- The level of trust is high (cf 50).
- The level of conflict is medium (cf 100).
- The employee morale is medium (cf 100).
- Rewards are given in a moderately equitably fashion (cf 100).
- The resistance to change is high (cf 100).
- The leader credibility is high (cf 100).
- The level of scapegoating is high (cf 100).

THE SIZE

The size of the organization - large, medium, or small - is based upon the number of employees, adjusted for their level of education or technical skills.

Based on the answers you provided, it is most likely that your organization's size is large (cf 100).

Between 51 and 75 % of the people employed by JTF have a high level of education. Adjustments are made to this effect. The adjusted number of employees is greater than 2,000 and JTF is categorized as large.

THE CLIMATE

The organizational climate effect is the summary measure of people and behavior.

Based on the answers you provided, it is most likely that the organizational climate is a internal process climate (cf 79).

It could also be the that climate is a group (cf 74).

The internal process climate is a formalized and structured place to work. Procedures govern what people do. The leaders pride themselves on being good coordinators and organizers. Maintaining a smooth running organization is important. The long-term concerns are stability, predictability, and efficiency. Formal rules and policies hold the organization together.

Employees with a medium to low morale is frequently one element of an internal process climate. High resistance to change is normally present in a internal process climate. An organization with a high level of scapegoating may have an internal process climate.

The group climate is characterized as a friendly place to work where people share a lot of themselves. It is like an extended family. The leaders, or head of the organization, are considered to be mentors and, perhaps even parent figures. The organization is held together by loyalty or tradition. Commitment is high. The organization emphasizes the long-term benefit of human resource development with high cohesion and morale being important. Success is defined in terms of sensitivity to customers and concern for people. The organization places a premium on teamwork, participation, and consensus.

Employees with a medium morale can be one element of group climate. High leader credibility characterizes an organization with a group climate. When the organization has a high level of trust it is likely that the organization has a group climate.

THE MANAGEMENT STYLE

The level of management's microinvolvement in decision making is the summary measure of management style. Leaders have a low preference for microinvolvement; managers have a high preference for microinvolvement.

Based on the answers you provided, it is most likely that your management profile has a high preference for microinvolvement (cf 90).

The management of JTF has a preference for making most of the decisions itself. This will lead toward a high preference for microinvolvement. Since the management has a preference for being very involved in gathering and using detailed information when making decisions, a high preference for microinvolvement characterization is appropriate. Management is risk averse. This is one of the characteristics of a manager with a high preference for microinvolvement. Management has a preference for using control to coordinate activities, which leads toward a high preference for microinvolvement.

THE STRATEGY

The organization's strategy is categorized as one of either prospector, analyzer with innovation, analyzer without innovation, defender, or reactor. These categories follow Miles and Snow's typology. Based on your answers, the organization has been assigned to a strategy category. This is a statement of the current strategy; it is not an analysis of what is the best or preferred strategy for the organization.

Based on the answers you provided, it is most likely that your organization's strategy is a defender strategy (cf 84).

An organization with a defender strategy is an organization that has a narrow product market domain. Top managers in this type of organization are expert in their organization's limited area of operation but do not tend to search outside their domains for new opportunities. As a result of this narrow focus, these organizations seldom need to make major adjustments in their technology, structure, or methods of operation. Instead, they devote primary attention to improving the efficiency of their existing operations.
JTF has few products. It needs to defend these products well in the marketplace. Viability depends on being successful with these limited activities. For a company with a high capital investment, the ability to adjust its capital base quickly is not likely. Thus, it needs to protect and defend its position; a defender strategy and technology protection is appropriate. A low price is generally a sign of a defender. JTF has a high price level and needs to be competitive both on quality and/or prices. If the organization defends a high quality brand then a high price can be charged. With a concern for high quality a defender strategy is a likely strategy for JTF. When the top management of JTF has a preference for a high level of microinvolvement, the strategy is likely to be defender.

THE CURRENT ORGANIZATIONAL CHARACTERISTICS

Based on your answers, the organization's complexity, formalization, and centralization have been calculated. This is the current organization. Later in this report, there will be recommendations for the organization.

The current organizational complexity is high (cf 100).

The current horizontal differentiation is high (cf 100).

The current vertical differentiation is high (cf 100).

The current spatial differentiation is medium (cf 100).

The current centralization is high (cf 100).

The current formalization is high (cf 100).

The current organization has been categorized with respect to formalization, centralization, and complexity. The categorization is based on the input you gave and does not take missing information into account.

SITUATION MISFITS

A situation misfit is an unbalanced situation among the contingency factors of management style, size, environment, technology, climate, and strategy.

The following misfits are present: (cf 100).

When many factors in the environment affect the organization, it may make it difficult for a defender like JTF to protect what it does and also difficult to protect its established market position. Therefore, the defender strategy is not appropriate! An analyzer strategy is more appropriate for this complex environment. Here the analyzer should seek out opportunities in the complex environment.

ORGANIZATIONAL CONSULTANT RECOMMENDATIONS

Based on your answers about the organization, its situation, and the conclusions with the greatest certainty factor from the analyses above Organizational Consultant has derived recommendations for the organization's configuration, complexity, formalization, and centralization. There are also recommendations for coordination and control, the appropriate media richness for communications, and incentives. More detailed recommendations for possible changes in the current organization are also provided.

ORGANIZATIONAL CONFIGURATIONS

The most likely configuration that best fits the situation has been estimated to be a functional configuration (cf 87).

It is certainly not: a professional bureaucracy (cf -3).

It is certainly not: a matrix (cf -8).

It is certainly not: a machine bureaucracy (cf -100).

A functional organization is an organization with unit grouping by functional specialization (production, marketing, etc.).
For a large organization with only few products, the functional configuration is recommended.
When the equivocality of JTF's environment is not high and the organizational complexity is not

low, the configuration should be functional. A functional configuration is usually required when the strategy is defender. An organization with an internal process climate could have a functional configuration.

Because of the low foreign product and service diversity and the low international involvement of JTF, the configuration should be a global functional configuration.

With its many international activities the functional structure may be a global organization.

A professional bureaucracy is a less likely configuration when top management has a high preference for microinvolvement.

The matrix configuration is usually not a very efficient configuration when the top management has a high desire for control.

When the organization is confronted with hostility, it cannot be a machine bureaucracy. A machine bureaucracy cannot act appropriately when unexpected events occur.

ORGANIZATIONAL CHARACTERISTICS

The recommended degree of organizational complexity is low (cf 74).

When the environmental hostility of JTF is high, organizational complexity should be low. Top management of JTF has a preference for a high level of microinvolvement, which leads to lower organizational complexity.

The recommended degree of horizontal differentiation is low (cf 74).

The recommended degree of vertical differentiation is low (cf 87).

The recommended degree of formalization is high (cf 74).

There should high formalization between the organizational units but less formalization within the units due to the high professionalization. When the organization uses an advanced information system, formalization should be high. JTF has a defender strategy, which generally requires a high formalization. A defender needs cost efficiency, and that can be obtained through formalization. JTF has a high capital requirement, which leads to high formalization. Large organizations should have high formalization. High formalization is consistent with top management's preference for a high level of microinvolvement. An internal process climate in the organization requires a high level of formalization.

The recommended degree of centralization is high (cf 85).

There is evidence against it should be: low (cf -21).

JTF has a defender strategy, which generally leads to high centralization. A defender needs cost efficiency, and that can be obtained through centralized coordination. When there is a high capital requirement and the product innovation is medium, as is the case for JTF, centralization should be rather high to obtain efficiency. When the environment is extremely hostile, top management must take prompt action and centralization must be high. High centralization is required if top management has a preference for a high level of microinvolvement. Because JTF has an advanced information system, centralization can be greater than it could otherwise. An internal process climate in the organization requires a medium to high level of centralization.

JTF's span of control should be moderate (cf 62).

Since JTF has some technology routineness, it should have a moderate span of control.

JTF should use media with low media richness (cf 100).

The information media that JTF uses should provide a moderate amount of information (cf 85).

Incentives should be based on procedures (cf 85).

JTF should use rules as means for coordination and control (cf 88).

With low equivocality, low uncertainty, and high complexity in JTF's environment, coordination and control should be rules and procedures. A moderate amount of information must be considered, although it need not be rich for this low uncertainty and low equivocality environment. Incentives should be based on procedure, thus focusing on performing activities well.
Top management will make most decisions and oversee their implementation. Top management will require a lot of detailed information, which will be generated by the functional hierarchy.

ORGANIZATIONAL MISFITS

Organizational misfits compares the recommended organization with the current organization.

The following organizational misfits are present: (cf 100).

Current and prescribed configuration do not match.
Current and prescribed complexity do not match.

MORE DETAILED RECOMMENDATIONS

There are a number of more detailed recommendations (cf 100).

You may consider decreasing the number of levels in the organization.

END

Appendix B – Global Terror Scenario

REPORT SUMMARY - JTF

Time: 1:44:34 PM, 3/4/2005
Scenario: Global Terror

INPUT DATA SUMMARY

The description below summarizes and interprets your answers to the questions about your organization and its situation. It states your answers concerning the organization's current configuration, complexity, formalization, and centralization. Your responses to the various questions on the contingencies of age, size, technology, environment, management style, cultural

climate and strategy factors are also given. The writeup below summarizes the input data for the analysis.

- JTF has a machine bureaucracy configuration (cf 100).
- JTF has a large number of different jobs (cf 100).
- Of the employees at JTF 51 to 75 % have an advanced degree or many years of special training (cf 100).
- JTF has more than 12 vertical levels separating top management from the bottom level of the organization (cf 100).
- The mean number of vertical levels is 9 to 12 (cf 100).
- JTF has more than 30 separate geographic locations (cf 100).
- JTF's average distance of these separate units from the organization's headquarters is 501 to 3,500 miles (cf 100).
- 61 to 90 % of JTF's total workforce is located at these separate units (cf 100).
- Job descriptions are available for all employees, including senior management (cf 100).
- Where written job descriptions exist, the employees are supervised closely to ensure compliance with standards set in the job description (cf 100).
- The employees are allowed to deviate very little from the standards (cf 100).
- 81 to 100 % non-managerial employees are given written operating instructions or procedures for their job (cf 100).
- The written instructions or procedures given are followed to a very great extent (cf 100).
- Supervisors and middle managers are to a little extent free from rules, procedures, and policies when they make decisions (cf 100).
- More than 80 % of all the rules and procedures that exist within the organization are in writing (cf 100).
- Top Management is to a very great extent involved in gathering the information they will use in making decisions (cf 100).
- Top management participates in the interpretation of more than 80 % of the information input (cf 100).
- Top management directly controls more than 80 % of the decisions executed (cf 100).
- The typical middle manager has some discretion over establishing his or her budget (cf 100).
- The typical middle manager has no discretion over how his/her unit will be evaluated (cf 100).
- The typical middle manager has no discretion over the hiring and firing of personnel (cf 100).
- The typical middle manager has no discretion over personnel rewards - (ie, salary increases and promotions) (cf 100).
- The typical middle manager has some discretion over purchasing equipment and supplies (cf 100).
- The typical middle manager has no discretion over establishing a new project or program (cf 100).
- The typical middle manager has little discretion over how work exceptions are to be handled (cf 100).
- JTF has 50000 employees (cf 100).
- JTF's age is mature (cf 100).
- JTF's ownership status is public (cf 100).
- JTF has few different products (cf 100).
- JTF has many different markets (cf 100).
- JTF operates at a high-activity level in more countries (cf 100).
- JTF has few different products in the foreign markets (cf 100).
- JTF's major activity is categorized as service (cf 100).
- JTF has a specialized customer-oriented service technology (cf 100).
- JTF has a nonroutine technology (cf 100).
- JTF's technology is a little divisible (cf 100).
- JTF's technology dominance is weak (cf 100).
- JTF has either planned or already has an advanced information system (cf 100).
- JTF's environment is complex (cf 100).
- The uncertainty of JTF's environment is high (cf 100).

- The equivocality of the organization's environment is high (cf 100).
- JTF's environment is extremely hostile (cf 100).
- Top management prefers to make general decisions as well as detailed operating decisions (cf 100).
- Top management primarily prefers to make both long-term and short-time decisions (cf 100).
- Top management has a preference for very detailed information when making decisions (cf 100).
- Top management has a preference for proactive actions (cf 100).
- Top management is risk averse (cf 100).
- Top management has a preference for high control (cf 100).
- JTF operates in an industry with a low capital requirement (cf 100).
- JTF has a medium product innovation (cf 100).
- JTF has a medium process innovation (cf 100).
- JTF has a high concern for quality (cf 100).
- JTF's price level is high relative to its competitors (cf 100).
- The level of trust is high (cf 50).
- The level of conflict is medium (cf 100).
- The employee morale is medium (cf 100).
- Rewards are given in a moderately equitably fashion (cf 100).
- The resistance to change is high (cf 100).
- The leader credibility is high (cf 100).
- The level of scapegoating is high (cf 100).

THE SIZE

The size of the organization - large, medium, or small - is based upon the number of employees, adjusted for their level of education or technical skills.

Based on the answers you provided, it is most likely that your organization's size is large (cf 100).

Between 51 and 75 % of the people employed by JTF have a high level of education. Adjustments are made to this effect. The adjusted number of employees is greater than 2,000 and JTF is categorized as large.

THE CLIMATE

The organizational climate effect is the summary measure of people and behavior.

Based on the answers you provided, it is most likely that the organizational climate is a internal process climate (cf 79).

It could also be the that climate is a group (cf 74).

The internal process climate is a formalized and structured place to work. Procedures govern what people do. The leaders pride themselves on being good coordinators and organizers. Maintaining a smooth running organization is important. The long-term concerns are stability, predictability, and efficiency. Formal rules and policies hold the organization together.

Employees with a medium to low morale is frequently one element of an internal process climate. High resistance to change is normally present in a internal process climate. An organization with a high level of scapegoating may have an internal process climate.

The group climate is characterized as a friendly place to work where people share a lot of themselves. It is like an extended family. The leaders, or head of the organization, are considered to be mentors and, perhaps even parent figures. The organization is held together by loyalty or

tradition. Commitment is high. The organization emphasizes the long-term benefit of human resource development with high cohesion and morale being important. Success is defined in terms of sensitivity to customers and concern for people. The organization places a premium on teamwork, participation, and consensus.

Employees with a medium morale can be one element of group climate. High leader credibility characterizes an organization with a group climate. When the organization has a high level of trust it is likely that the organization has a group climate.

THE MANAGEMENT STYLE

The level of management's microinvolvement in decision making is the summary measure of management style. Leaders have a low preference for microinvolvement; managers have a high preference for microinvolvement.

Based on the answers you provided, it is most likely that your management profile has a high preference for microinvolvement (cf 90).

The management of JTF has a preference for making most of the decisions itself. This will lead toward a high preference for microinvolvement. Since the management has a preference for being very involved in gathering and using detailed information when making decisions, a high preference for microinvolvement characterization is appropriate. Management is risk averse. This is one of the characteristics of a manager with a high preference for microinvolvement. Management has a preference for using control to coordinate activities, which leads toward a high preference for microinvolvement.

THE STRATEGY

The organization's strategy is categorized as one of either prospector, analyzer with innovation, analyzer without innovation, defender, or reactor. These categories follow Miles and Snow's typology. Based on your answers, the organization has been assigned to a strategy category. This is a statement of the current strategy; it is not an analysis of what is the best or preferred strategy for the organization.

Based on the answers you provided, it is most likely that your organization's strategy is a defender strategy (cf 77).

It could also be: a prospector (cf 72).

It could also be: an analyzer without innovation (cf 70).

An organization with a defender strategy is an organization that has a narrow product market domain. Top managers in this type of organization are expert in their organization's limited area of operation but do not tend to search outside their domains for new opportunities. As a result of this narrow focus, these organizations seldom need to make major adjustments in their technology, structure, or methods of operation. Instead, they devote primary attention to improving the efficiency of their existing operations.
JTF has few products. It needs to defend these products well in the marketplace. Viability depends on being successful with these limited activities. A low price is generally a sign of a defender. JTF has a high price level and needs to be competitive both on quality and/or prices. If the organization defends a high quality brand then a high price can be charged. With a concern for high quality a defender strategy is a likely strategy for JTF. When the top management of JTF has a preference for a high level of microinvolvement, the strategy is likely to be defender.

An organization with a prospector strategy is an organization that continually searches for market opportunities and regularly experiments with potential responses to emerging environmental trends. Thus, the organization is often the creator of change and uncertainty to which its competitors must respond. However, because of its strong concern for product and market innovation, a prospector usually is not completely efficient.

A non-routine technology is likely to be costly for JTF, and a prospector strategy of new product development where margins are likely to be high is very reasonable. With high prices, JTF is likely to attract competition and imitation. A prospector strategy of constant development is necessary. With a concern for high quality a prospector strategy is a likely strategy for JTF.

An organization with an analyzer without innovation strategy is an organization whose goal is to move into new products or new markets only after their viability has been shown yet maintains an emphasis on its ongoing products. It has limited innovation related to the production process; generally an analyzer without innovation does not have product innovation.

The capital requirement of JTF is not high, which is consistent with an analyzer without innovation strategy. With a concern for high quality an analyzer without innovation strategy is a likely strategy for JTF. With top management of JTF preferring a high level of microinvolvement, the strategy is likely to be analyzer without innovation.

THE CURRENT ORGANIZATIONAL CHARACTERISTICS

Based on your answers, the organization's complexity, formalization, and centralization have been calculated. This is the current organization. Later in this report, there will be recommendations for the organization.

The current organizational complexity is high (cf 100).

The current horizontal differentiation is high (cf 100).

The current vertical differentiation is high (cf 100).

The current spatial differentiation is high (cf 100).

The current centralization is high (cf 100).

The current formalization is high (cf 100).

The current organization has been categorized with respect to formalization, centralization, and complexity. The categorization is based on the input you gave and does not take missing information into account.

SITUATION MISFITS

A situation misfit is an unbalanced situation among the contingency factors of management style, size, environment, technology, climate, and strategy.

The following misfits are present: (cf 100).

JTF has both a defender strategy and many different markets and/or products. In some situations, this may cause problems! A defender strategy is easier to manage for a few products or markets as management can focus attention on a few issues well. Defender strategies are difficult to sustain for a large number of products; there is a high probability that some products and markets will require innovation and new developments. The recognition of when to give up a defensive strategy for a given product or market requires a good deal of management attention and the need for change is frequently missed or realized late; needed adaptation is then even more difficult. For many products or markets, a uniform defender strategy is likely to be a mismatch for some products or markets. A complex and mixed strategy is required.

When the environment is not well defined - that is, when the organization cannot anticipate the important environmental factors - the defender strategy is not appropriate! A defender strategy is not innovative or adaptive. In an ill-defined environment, adaptation will be required to survive as new situations and issues will emerge. Here the organization should change its strategy to an analyzer or prospector to adapt to the evolving and changing environment.

Since JTF operates in a highly uncertain environment, the defender strategy is most likely inappropriate. With a highly uncertain environment, the environmental variable values change in large amounts and can vary in the extreme. The defender is trying to maintain the status quo and defend its market share, product lines, production processes, etc. This is risky as the market or other environmental values change outside the range of the defender's position. Then there is a serious mismatch between what the defender is doing and what the market will support. Here the organization must prepare to shift quantities and perhaps products to meet the uncertainty in the environment. An analyzer strategy is probably more appropriate.

When many factors in the environment affect the organization, it may make it difficult for a defender like JTF to protect what it does and also difficult to protect its established market position. Therefore, the defender strategy is not appropriate! An analyzer strategy is more appropriate for this complex environment. Here the analyzer should seek out opportunities in the complex environment.

JTF has a low capital requirement but is a large organization. Small competitors may be a threat to some of JTF's markets. Low capital requirements are usually associated with low barriers to entry. Small competitors can enter and frequently, with more advanced technology and lower costs. Large organizations are frequently slow to adjust and adapt. The smaller competitor will have the advantage and thus, be a threat. One alternative is to break up the large organization into a number of smaller ones.

JTF is a large organization with a complex and dynamic environment. This may not fit with the managements preference for a high level of microinvolvement! With a complex and dynamic environment, there are a very large number of changing situations to which to adjust. Management cannot access all the situations, analyze what needs to be done and oversee the implementation. There is simply too much to do; there is too much information to deal with. A high level of microinvolvement will usually lead to an information overload at the top and a delay in action when it is most needed. Despite a tendency for management to become even more involved in details, the situation requires less microinvolvement and alternative approaches, such as more decentralization.

JTF has an internal process climate. This may cause problems in a high or moderately high equivocal environment! An internal process climate focuses more on the inside of the organization than on the outside. In an equivocal environment which is likely to require change and adaptation, the internal process climate may not either see the shift, understand the need for change and does not have an organization which supports adaptation to such needed change. There is high resistance to change. An equivocal environment requires an external orientation which is found in the rational goal and development climates.

JTF has an internal process climate. This is a mismatch with a non routine technology! An internal process climate is internally and control oriented. A routine technology with a similar focus on implementing standard ways of doing things is a better fit for an internal process climate. For a non routine technology, a climate with more flexibility would be better.

ORGANIZATIONAL CONSULTANT RECOMMENDATIONS

Based on your answers about the organization, its situation, and the conclusions with the greatest certainty factor from the analyses above Organizational Consultant has derived recommendations for the organization's configuration, complexity, formalization, and centralization. There are also recommendations for coordination and control, the appropriate media richness for communications, and incentives. More detailed recommendations for possible changes in the current organization are also provided.

ORGANIZATIONAL CONFIGURATIONS

The most likely configuration that best fits the situation has been estimated to be a simple configuration (cf 83).

It is certainly not: a professional bureaucracy (cf -100).

It is certainly not: a functional (cf -100).

It is certainly not: a machine bureaucracy (cf -100).

It is certainly not: a divisional (cf -100).

A simple organization has a flat hierarchy and a singular head for control and decision making. The primary reason for recommending a simple configuration is that the organization has extreme environmental hostility. Extreme environmental hostility requires that the organization can respond consistently and rapid to unforeseen challenges. Therefore, it must have a simple configuration. A nonroutine technology together with a desire from top management for a concentration of control make a simple configuration possible and likely.

Because the organization does not have a routine technology, it is not likely that a professional bureaucracy is an efficient organization.
A professional bureaucracy is a less likely configuration when top management has a high preference for microinvolvement.
The configuration cannot be a functional configuration when the technology is nonroutine.
When the organization has a nonroutine technology, it is not likely that a machine bureaucracy is an efficient organization.When the organization is confronted with hostility, it cannot be a machine bureaucracy. A machine bureaucracy cannot act appropriately when unexpected events occur. Because the technology is not divisible, the configuration cannot be divisional.

ORGANIZATIONAL CHARACTERISTICS

The recommended degree of organizational complexity is low (cf 79).

Not much is known about the environment since both the environmental uncertainty and the environmental equivocality of JTF are high. In this situation, the organizational complexity should be low. This allows the organization to adapt quickly. When the environmental hostility of JTF is high, organizational complexity should be low. Top management of JTF has a preference for a high level of microinvolvement, which leads to lower organizational complexity.

The recommended degree of horizontal differentiation is low (cf 79).

The recommended degree of vertical differentiation is low (cf 79).

The recommended degree of formalization is low (cf 80).

When the organization is in the service industry and it does not have a routine technology, its formalization should be lower than if it had been in the manufacturing industry. JTF has a low capital requirement and a medium product innovation, which leads to lower degree of formalization. Organizations with nonroutine technology should have low formalization. Since the set of variables in the environment that will be important is not known and since it is not possible to predict what will happen, no efficient rules and procedures can be developed, which implies that JTF's formalization should be low. When environmental hostility is high formalization should be low.

The recommended degree of centralization is high (cf 73).

JTF has a defender strategy, which generally leads to high centralization. A defender needs cost efficiency, and that can be obtained through centralized coordination. When the environment is extremely hostile, top management must take prompt action and centralization must be high. High centralization is required if top management has a preference for a high level of microinvolvement. Because JTF has an advanced information system, centralization can be greater than it could otherwise. An internal process climate in the organization requires a medium to high level of centralization.

JTF's span of control should be narrow (cf 65).

Since JTF has a nonroutine technology, it should have a narrow span of control.

JTF should use media with high media richness (cf 91).

The information media that JTF uses should provide a large amount of information (cf 91).

Incentives should be based on results (cf 91).

JTF should use meetings as means for coordination and control (cf 91).

With a nonroutine technology JTF should obtain coordination and control via group meetings. Media with high richness and large amount of information should be used. Incentives should be based on results.When the environment of JTF has high equivocality, high uncertainty, and high complexity, coordination and control should be obtained through integrators and group meetings. The richness of the media should be high with a large amount of information. Incentives must be results based.Top management should play the central role in coordinating and controlling the activities of the organization as well as making strategic and operating decisions.
Top management should gather information, make decisions, and manage implementation. Top management should give direct orders to achieve the required coordination among the operations and activities.

ORGANIZATIONAL MISFITS

Organizational misfits compares the recommended organization with the current organization.

The following organizational misfits are present: (cf 100).

Current and prescribed configuration do not match.
Current and prescribed complexity do not match.
Current and prescribed formalization do not match.

MORE DETAILED RECOMMENDATIONS

There are a number of more detailed recommendations (cf 100).

You may consider decreasing the number of levels in the organization.
You may consider decreasing the number of positions for which job descriptions are available.
You may consider supervising the employees less closely.
You may consider allowing employees more latitude from standards.
You may consider fewer written job descriptions.
Managerial employees may be asked to pay less attention to written instructions and procedures.
You may give supervisors and middle managers fewer rules and procedures.
You may consider having fewer rules and procedures put in writing.

END

Requirements & Transformations for Edge Organizations – Part I

IC2RTS 2005 Edge Organizations Track

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Motivation

- Edge organization is fresh OD approach
- Question comparative & contingent performance
- Research problems with methods & contradictions
- COT as bridge method
- Center for Edge Power: MY, MD, MU R program
- This study:
  - Phase 1 – specify requirements & transformation pathways
  - Characterize C2 orgs appropriate for war on global terror

Contingency Theory

- No one, "best" way to organize
- Rational, design view of organizations
- Contingencies: environment, technology, interdependence, I-processing, others
- Organize to improve & maintain "fit"
- See Lawrence & Lorsch (67), Perrow (67), Thompson (67), Galbraith (77), others

Organization Consultant

- Scholarship-based expert system
- Research propositions → ES rules
- Input: 6 org dimensions (Q&A)
- Output (rule-based inference):
  - Diagnose misfits
  - Recommend transformations
- See Burton & Obel (04)

Diagnosing C2 Organizations

- JTF unit of analysis
- Analyze as Hierarchy (Alberts & Hayes 03)
- 2 mission-environmental scenarios:
  - "Cold War" – relatively stable & predictable
  - "Global Terror" – relatively problematic & challenging
- ID misfits, requirements & transformations
- Analyze Edge characterizations also

Scenario Differences

Table 2 Input Differences between Cold War & Global Terror Scenarios

Cold War	Global Terror
6 – 15 separate locations	Greater than 30 locations
100 – 500 mi ave distance	500 – 3500 mi ave distance
Few different markets	Many different markets
Few foreign markets	Many foreign markets
Standard, hi-volume technology	Specialized, custom technology
Semi-routine technology	Non-routine technology
Semi-divisible technology	Indivisible technology
Strong dominant technology	Weak dominant technology
Low uncertainty	High uncertainty
Low equivocality	High equivocality
High capital	Low capital

OrgCon Results

- Cold War scenario
  - Good fit overall
  - Misfits: Defender strategy, H & V differentiation
- Global Terror scenario
  - Poor fit overall
  - Misfits: Defender strategy, H & V differentiation, large units, centralization, micromanagement, formalization, I-media, Bureaucracy, others

Edge Design Requirements

Table 3 Edge Organization Design Requirements

Organization Area	Design Requirements*
Organization size	Small, possibly specialized units
Climate	Externally focused: Rational Goal or Developmental; use fewer written rules and procedures
Management style	Less micro-involvement; rapid & reliable knowledge flows; incentives based on results; coordination through meetings; allow employees more latitude
Organizational characteristics	Less centralization, differentiation and formalization; Simple Structure with flat hierarchy
Technology	Specialized, custom, non-routine, indivisible, low-capital, heavy & rich information flows
Strategy	Prospector or Analyzer

* Transformation pathways correspond as a set.

Contributions

- Illustrate use & utility of COT in mil C2
- Ground Edge analysis in Contingency Theory
- ID relative fits & misfits of current C2 orgs
- Induce requirements for Edge org
- Delineate transformation pathways
- Action plan for leaders & policy makers
- Inputs for computational experiments

Limitations & Future Research

- Limitations
  - Bridge research method, interpretation & judgment
  - C2 is relatively new domain for OrgCon
- Future research
  - Analyze Edge orgs directly
  - Fieldwork for model validation, calibration, extension
  - Complementary studies ongoing & planned
  - Center for Edge Power welcomes informed input